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secondary schools" will receive any clear cut conception of the position and function of root hairs. It is, again, merely a question of adaptation.

It is needless to multiply illustrations bearing upon the point under consideration. The book seems to be prepared for the teacher rather than the pupil. In the hands of a skillful teacher fairly versed in elementary botany it will be found of high value and exceedingly suggestive. In the hands of a teacher without previous laboratory experience its value would be greatly impaired, if not utterly destroyed. As an indication that the book was prepared for the teacher may be taken Appendix II, "Suggestions to the teacher," which covers 45 pages of the volume, the "laboratory practice" covering 129 pages. So large a proportion of space being deemed necessary for instructions to teachers furnishes at least indirect support to the view suggested above. It is a question as to whether pupils should be required to pay for suggestions to teachers, at least in such large measure.

After all, this is a criticism of a condition in our educational system rather than of Dr. Setchell's book. Conditions are so variant in the secondary schools of the country that the work possible for them, either as to content or extent, cannot yet be determined. The wide range of subjects taught, save in extremely exceptional cases, by every teacher in the secondary schools, precludes for the present, at least, the introduction of many of the methods of the specialist as well as many of his problems. The tendency is as mistaken as strong which is in the direction of the introduction of college and university methods into secondary schools. The chief objection to Dr. Setchell's book lies in the fact that it intensifies this tendency, that it fails to recognize the difference in conditions, indeed the difference in purpose which exists between secondary schools and universities.

The book will prove extremely helpful in elementary work in colleges and universities, and will find its way into the library of every teacher even though it does not entirely meet the needs of the secondary schools. Dr. Setchell is to be congratulated, not merely upon an honest attempt to solve a difficult problem, but also upon the production of a book which, both in form of presentation and content, is full of helpful suggestions.—S. C.

Cytological studies.

A notable volume² has recently come from the laboratory of Professor Strasburger. With certain important cytological problems to investigate, Professor Strasburger secured data from a wide range of forms by distribut-

² STRASBURGER (Eduard), OSTERHOUT (W. J. V.), MOTTIER (David M.), JUEL (H. O.), DEBSKI (Bronislaw), HARPER (R. A.), FAIRCHILD (D. G.), SWINGLE (Walter T.).—Cytologische Studien aus dem Bonner botanischen Institut. Separatabdruck aus den Jahrbüchern für wissen. Bot. 30: 1-268, pl. 18. 1897. [Heft 2 u. 3]. Berlin: Gebrüder Borntraeger. M 27.50.

ing the work among seven of his research students. This method of securing large results from some single problem, rather than small results from scattered problems, commends itself to every laboratory in which a group of research students may be working. We are pleased to note that of the seven collaborators five are American students.

Osterhout investigated the spore mother cells of *Equisetum limosum*, with especial reference to the question of the existence of centrosomes and their participation in the process of spindle formation. He gives perhaps the most complete series of stages in the development of the spindle that has yet been worked out in a vascular plant. The sequence of events is briefly as follows: kinoplasmic fibers form (1) a felted layer around the nucleus; (2) they are radially placed; (3) the fibers gather in bundles; (4) the nuclear membrane disappears and the fibers come in connection with the linin network and the chromosomes; (5) the fiber bundles are arranged in two groups to form finally a bipolar spindle. Centrosomes are not found and could play no part in the process as described. The author also figures characteristic tetrad chromosomes.

Mottier has made further studies on the pollen mother cells of a number of lilies and dicotyledons, chiefly with reference to spindle development and chromosome reduction. As to the method of spindle formation, his results are in substantial agreement with those of Osterhout. He finds in lilies no such governing centers in mitosis as were described by Guignard. He shows also that the chromosomes in heterotypic division pass through essentially the same stages in the plants studied as have been described by later authors for animal nuclei, and argues strongly for the view that the numerical reduction of the chromosomes before the heterotypic division is only a pseudo-reduction, and that a qualitative division in Weismann's sense occurs in the second division. We must note that a later joint paper by Strasburger and Mottier³ revises this conclusion, and returns to the doctrine that every mitosis is accompanied by a longitudinal splitting of the chromosomes.

The formation of small supernumerary pollen grains in the pollen tetrads of *Hemerocallis* was studied by Juel. He finds, as Strasburger has described, that these grains in every case owe their origin to the isolation of individual chromosomes either before or after splitting in the equatorial plate. Such single chromosomes form nuclei which function as normal nuclei in every respect. If isolated in the first division the small nucleus forms a spindle and divides, just as its normal sister nuclei. It is difficult to see how centrosomes could be present for these micro-spindles. Juel also confirms, for *Hemerocallis*, the method of spindle development described by Osterhout and Mottier.

Debski finds in *Chara* a type of spindle and cell plate formation which

³ Über den zweiten Theilungsschritt in Pollenmutterzellen. Ber. d. deutsch. Bot. Ges. Heft 6. 1897.

resembles much more closely the process in vascular plants than in the algae to which Chara has been assumed to be more closely allied. The stages agree in general with those described by Osterhout. No functional centrosomes are to be found. "Extra nuclear nucleoles" are abundant, and seem to furnish material for the spindle fibers and cell plate. The structures assumed by Kaiser to be centrosomes are doubtless such nucleolar masses.

In contrast to the method of spindle development described for the vascular plants and Chara, Harper finds in the ascus of *Erysiphe* a type much more nearly resembling that described for animal cells by Hermann and Flemming. A disk shaped central body is present with each nucleus throughout nuclear division and spore formation in the ascus. At the beginning of spindle building this body is surrounded by a system of radiating kinoplasmic fibers. Then two such centers appear beside the nucleus and separate gradually to form the poles of the spindle. From these centers fibers extend and are attached to the chromosomes. In the bounding off of the ascospores by free cell formation the polar radiations of the last preceding mitosis perform an entirely new function. They grow in length and swing back around the nucleus, which has been drawn out into a beak beneath the central body, and fuse laterally to form a new plasma membrane around the young spore. The bounding layer of the young ascospore is thus composed of the same kinoplasmic substance as the polar radiations and spindle fibers. The spore wall is formed much later.

In *Basidiobolus* Fairchild finds very characteristic barrel shaped multipolar spindles. The fibers converge in groups, and each group ends in a strongly staining body. These bodies, taken together, make up a sort of polar plate. Here also a typical cell plate is probably formed as in Chara. Fairchild further notes the very interesting fact that in *Basidiobolus* we have one of the shortest possible life histories, involving at the same time an alternation of sexual and asexual fruit forms. Two successive nuclear divisions may complete the entire round of conidium and zygospor formation.

Swingle has given for *Stypocaulon* the most complete description of a sharply differentiated centrosome, and its division and migration during spindle development, which has yet been worked out in plant cells. The process here, also, is much the same as in animal cells. The apical cell of this plant is almost constantly in division, and the polar radiations and centrosomes persist in it through the resting stages of the nucleus. The spindle has both "mantle" and "central" fibers, and at the time of its greatest development the polar radiations are much reduced. The amount of kinoplasm at the two poles is regularly unequal. The contrast in structure and reaction of the fibrous kinoplasm and alveolar trophoplasm is nowhere more sharply shown than in this apical cell of *Stypocaulon*. Cell division takes place without the aid of connecting "fibers" or constriction of the plasma

mass. A cell plate is formed in the trophoplasm and is split into two new plasma membranes before the building of the new cellulose wall.

Strasburger finds that the oogonium nucleus of *Fucus* shows the reduced number of chromosomes in its first division after the stalk cell has been cut off. Centrosomes in the *Fucus* cell are sharply differentiated, and the spindle is formed much as in *Stylocaulon*. In cell division in the oogonium the cell-plate appears first as a layer of granules, each of which divides, and the so formed elements fuse to form the bounding membranes of the daughter cells. Fusion of the male and female pronuclei and the first division of the fertilized egg nucleus are also described. Centrosomes in connection with these pronuclei were not observed, but the presence of such a body with the antherozoid nucleus is regarded by Strasburger as not improbable. He also gives a résumé of the results presented in the different papers, and a more theoretical discussion of their bearing on doctrines of cell structure and reproduction.

While zoologists are inclining to the conclusion that the archiplasm of Bovéri is only a structurally modified portion of the common cytoplasmic mass, the evidence in all the above studies goes to show that there are two substances, kinoplasm and trophoplasm, in the cytoplasm of the plant cell, distinct both in structure and chemical composition, and readily distinguishable by their visible structure and staining properties. To the kinoplasm falls the active work of mitosis, in many cases of cell division. In the ascus it covers the entire surface of the young spore, which suggests that the *Hautschicht* may be also kinoplasmic.

We must conclude, so far as existing evidence is concerned, that there are two widely distinct types of spindle formation, the one occurring in animals and many of the lower plants, the other in the higher vascular plants. In the first the forces of mitosis act in centered systems, while in the other the kinoplasmic fibers singly or in bundles are the acting units.

The work of Mottier and Osterhout serves to emphasize greatly the similarity between the chromosome figures in animal and plant cells in the so-called heterotypic mitosis. The interpretation of these figures, however, remains still in doubt.

The whole series of studies is of great importance, and a review can do it but scant justice. The conclusions reached demand such a readjustment of former ideas that real criticism must await further investigation. Any theory, however, which differentiates the higher from the lower plants in these fundamental cell processes seems likely to have an uncertain tenure, especially as it associates the lower plants with animals. The tendency of investigation has been to establish similarity rather than diversity in all fundamental life phenomena. This objection is purely theoretical, of course, but it is so firmly entrenched in the minds of biologists that the proof to the contrary will

have to be very strong. We cannot help but feel that while the observations recorded in these "studies" are of great interest, some of the conclusions are entirely too sweeping. The occurrence of centrosomes in the higher plants is far from settled, and the occurrence of a multipolar phase as necessarily antecedent to the bipolar phase of a spindle may be regarded as still an open question.

The result of these "studies" will be to stimulate investigation greatly rather than to command immediate belief in the more important conclusions, and investigation is always more important than belief.—J. M. C.

MINOR NOTICES.

T. D. A. COCKERELL⁴ has published a remarkably full list of the food plants of scale insects. The preparation of the summary has emphasized two facts, viz., "the unexpected number of coccids found on many of the cultivated trees and shrubs, and the frequency with which species dangerous to fruit trees will occur on ornamental plants, which may be carried from place to place and be the means of disseminating the scales."—J. M. C.

THE FOURTH PART of *Flora Franciscana*⁵ has just appeared, and is devoted to the Compositæ. As Professor Greene has been much concerned with various sections of this great group, it is of great interest to have the results of his studies brought together, so far as they can be within the limited range of this work. Space forbids mention of the numerous shifting of generic boundaries and the new species described. Many of the author's views of the genera of Compositæ have been published already, but the contribution before us contains much new material. The richness of the Californian flora may be judged by the fact that the portion of it represented in this *Flora* contains 113 genera of Compositæ, and 492 species. The general character of the composite flora may be judged from the following summary of the number of species under each of the ten groups called "sub-orders," and named as follows: Eupatoriaceæ 9, Asteraceæ 149, Gnaphaliaceæ 30, Ambrosiaceæ 7, Helianthaceæ 29, Madiaceæ 79, Helenioideæ 76, Anthemideæ 25, Senecionideæ 59, Cynarocephalæ 29.—J. M. C.

NOTES FOR STUDENTS.

ITEMS OF TAXONOMIC INTEREST are as follows: Karl M. Wiegand⁶ has been studying *Galium trifidum* and its North American allies, and finds that this reputed "variable species" is a plexus of forms. He has used the form

⁴ Proc. U. S. Nat. Mus. 19:725-785. 1897.

⁵ GREENE, EDWARD L.—*Flora Franciscana*. An attempt to classify and describe the vascular plants of middle California. Part IV. Pp. 353-480. San Francisco: Payot, Upham & Co. London: William Wesley & Son. 1897. \$1.00

⁶ Bull. Torr. Bot. Club 24:389-403. 1897.